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GPPR - A MULTIPURPOSE COMPUTER CODE FOR DATA PLOTTING

M. J. Caddy
Air Vehicle Technology Department
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974

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A general purpose computer code is described which generates Calcomp Pen Plots suitable for reports and other documents. The code was developed using the NAVAIRDEVCEN CDC 6600/CYBER 175 computer facilities.

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INTRODUCTION

The NAVAIRDEVCEN (Naval Air Development Center) is a large user of vehicle and propulsion design and performance computer codes. A significant number of these programs is dependent on the use of input tabular data sets. Experience has shown that it is desirable to have a visual representation of these data sets prior to use in these programs to avoid employing incorrect data. In addition, the programs often require a means of expressing output results in a form other than digital data. This present report describes a general purpose routine which will generate data plots in terms of one or two independent variables. This code, entitled GPPR (General Purpose Plotting Routine) for plotting data, was developed for the NAVAIRDEVCEN CDC 6600/CYBER 175 computer facilities and is used in conjunction with a model 735 CALCOMP pen plotter. A user's guide for this code is shown in Appendix A. A sample problem is illustrated in Appendix B and a FORTRAN code listing is given in Appendix C.

DISCUSSION

CODE DESCRIPTION

The GPPR code was developed as a computer tool to permit users to easily and quickly plot digital data for both use in reports and editing of table data sets used as inputs in other computer codes. A completely general plotting routine was thought to be awkward and inconvenient to the user, because of the large numbers of inputs that would be required. For this reason decisions were made which restrict the options related to the plot size and axis labeling. The code package consists of subroutines GPPR, AXSCALE, and function SPLNQ1. A user written main program is required to use the plot package. An example of a main program is shown in Appendix C.

The basic features and options selected for the GPPR subroutine are as follows:

Plot Size

The standard size GPPR plot is 8.5 by 11 inches which is compatible with present NAVAIRDEVCEN report page size. The manner in which these plots are produced on the CALCOMP Pen Plotter is shown in Figure 1. The entire plot size (all symbols, scales, and other characters) may be changed from the standard size through an input size factor. For example plots of 4.25 by 5.5 inches would be obtained with an input size factor equal to .5.

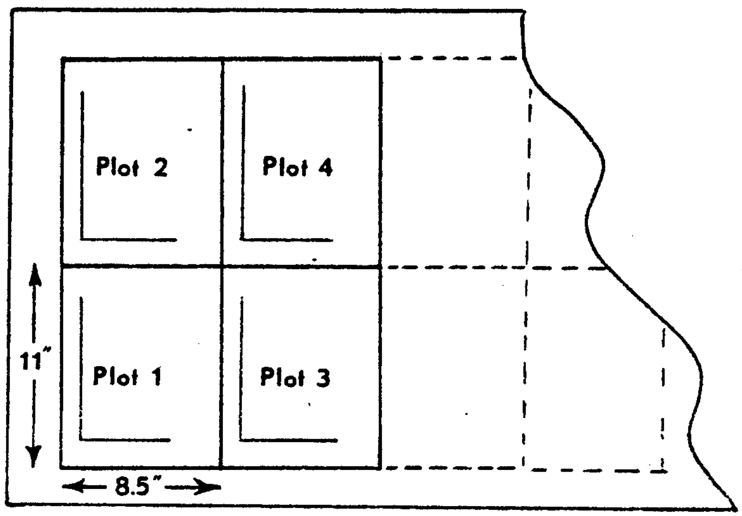

FIGURE 1. GPPR OUTPUT FROM CALCOMP PEN PLOTTER

Titles, Axis Labeling and Increment Size

The standard size axis lengths are 5 and 7 inches, respectively, with tic marks provided at one inch intervals. The scale and increment size for each axis is determined from another subroutine, AXSCALE. The AXSCALE routine determines the largest scale and increment size that will permit all data points to lie within the boundary, .01 inch less than the start of and .05 inch greater than the end of each axis. The AXSCALE routine will select the correct scale and increment size in multiples of 1, 2, or 5. This particular scale selection procedure enables the user to overlay the GPPR plot with 10 divisions per inch graph paper and accurately read values from the GPPR plot. For example, if y axis values ranged from 0 to 200, the axis label values would be 50 units per inch with a full scale value of 350. A FORTRAN listing of the AXSCALE code is found in Appendix C.

Each axis title label is input by the user. A title label option for a second independent variable is also provided. Each line of the main title heading is automatically centered over the plot. The entire main title heading may contain a maximum of four lines with no more than 35 characters per line.

Data Presentation

The GPPR routine has three options concerning presentation of data on each plot.

1. Option 1

The first option is to plot symbols for each input data point. If two or more second independent variables are input then different type symbols will be used for each group of points representing a constant value of the second independent variable.

2. Option 2

The second option is an extension of the first option. The symbols are plotted as in option 1 and an in-house developed cubic spline interpolation code, function SPLNQ1, based on methods in reference (a), is used to draw a smooth curve between each set of symbol types. The cubic spline interpolation technique is unique in that the interpolated curve passes through each data point and has continuous first and second derivatives. A FORTRAN code listing for function SPLNQ1 is given in Appendix C.

3. Option 3

The third option permits the user to plot the interpolated spline curve with symbols appearing only at each end of the spline curve. The symbols at the end of each spline curve are retained only to identify each curve in terms of the associated second independent variable value.

4. Grid Option

The grid option permits a 1 inch grid to be drawn at the tic marks on the axes. Instructions for using these options are given in Appendix A.

CONCLUSIONS AND RECOMMENDATIONS

The general purpose plotting routine discussed in this report is a valuable computer based tool. The GPPR subroutine is flexible and easily incorporated into new or existing computer codes.

The present structure of GPPR restricts usage to curves with open arcs and single values of the dependent variable at each independent variable. It is recommended that program development proceed which will extend GPPR to permit the plotting of data which can be the form of a closed arc.

REFERENCES

(a) Pennington, Ralph H., "Introductory Computer Methods and Numerical Analysis", Macmillian Company, London, 1970

APPENDIX A

USER'S GUIDE

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APPENDIX A
USER'S GUIDE

All inputs into the GPPR routine are passed as formal parameters in the call statement to GPPR. The order of the parameters in the call statement is as follows:

CALL GPPR (NPLOT, LABY, N1, LABX, N2, LABTL, NT, X, Y, NPTS, LABVAL, NCC, VLABL, NDECV, ITIP, IGRID, FAC)

These parameters are defined as follows:

NPLOT is an initializing parameter which is set to 0 before the first call to GGPR. NPLOT is only set once.

LABY is an array containing the Hollerith data for the Y axis label.

N1 is the number of elements in the LABY array comprising the Y axis label. (1 element = 10 characters)

LABX is an array containing the Hollerith data for the X axis label.

N2 is the number of elements in the LABX array comparisons for the X axis label (1 element = 10 characters).

LABTL is an array containing the Hollerith data for the main title label. Groups of 3 or more consecutive blank characters between non blank characters indicate the beginning of a new line in the title label. Space limitations permit a maximum of 4 lines with approximately 35 characters per title line. If the user attempts to use a title line longer than 35 characters, the line will terminate at the next blank after the thirty-fifth character in that line. Leading and trailing blank characters for each line are ignored and each line of title is centered on the plot.

NT is the number of elements in the LABTL array comprising the main title label (all lines) (1 element = 10 characters). If NT is equal to 0, no main title is written.

X is an array containing the X axis values of data for the entire plot. For example, consider a plot with three curves to be drawn as shown in Figure A-1. If the first curve has 6 data points and the second curve has 4 data points, then elements X(1) to X(6) are the X axis coordinate values for the first curve and elements X(7) to X(10) are the X axis coordinate values of the second curve. The third curve points would follow in X(11) to X(15). The order of the 6 points in the X array comprising the first curve is unimportant. Similarly, the order of the points comprising any curve is unimportant.

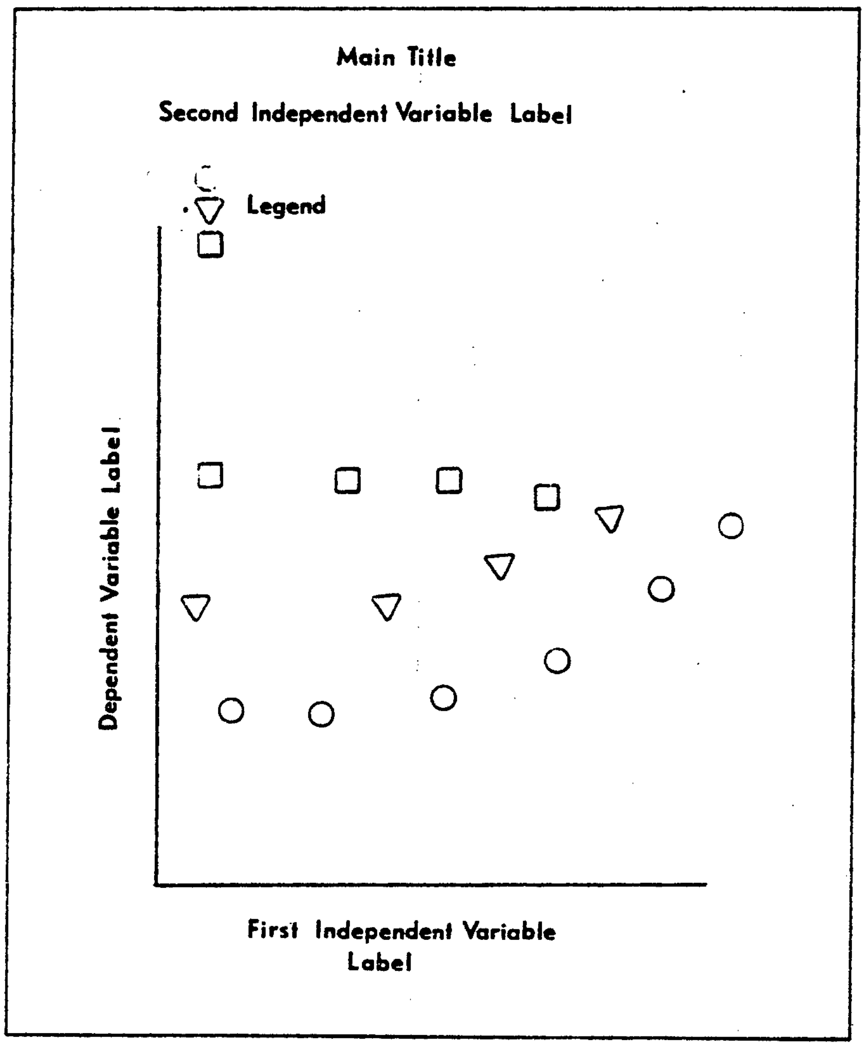

FIGURE A-1. GPPR EXAMPLE PLOT OPTION 1

Y is an array containing the Y axis values of data for the entire plot. There must be a one to one correspondence between the Y array values and the X array values. For example, X(1) and Y(1) are the X and Y axis coordinate values of the first input data point.

NPTS is an array containing the number of data points for each curve on the plot. In the preceeding example, NPTS (1) = 6, NPTS (2) = 4, and NPTS (3) = 5. The NPTS element following the last element used to identify the last curve must be set equal to zero. In this example, NPTS (4) must be set equal to 0.

LABVAL is an array containing the Hollerith data for the second independent title label. This title label is used identify the value held constant for each curve on the plot. (1 element of the array will contain 10 characters.)

NCC is the number of elements in the LABVAL array comprising the second independent variable (if NCC = 0 no second independent variable title is generated on the plot) title label (1 element = 10 characters).

VLABL is an array containing the values of the second independent variable associated with each curve. The first element of VLABL is associated with the first set of points in the X and Y arrays. If NCC is set equal to zero then VLABL is not applicable.

NDECV is the number of significant figures to the right of the decimal for the VLABL array to be used on the plot.

ITIP is a switch used to indicate the following options.

ITIP	OPTION
1	plot symbols only
2	plot symbols and draw a spline curve fitted with respect to X axis
3	same as ITIP = 2 except symbols are only plotted at end points of spline curve
-2	plot symbols and draw a spline curve fitted with respect to Y axis
-3	same as ITIP = -2 except symbols are only plotted at end points of the spline curve

IGRID is a switch used to indicate grid options. If IGRID = 1, a one inch grid is drawn on the plot. Otherwise, no grid is drawn.

FAC is a value indicating the size factor of the plots. FAC set to 1.0 is the standard size indicating plots 8.5 by 11 inches will be drawn.

The last step in any program using the GPPR subroutine is to end the plotting tape. To end the plotting tape the user must enter a call to GPPREND using the same formal parameters previously defined in the call to the GPPR subroutine.

APPENDIX B

SAMPLE PROBLEM

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APPENDIX B
SAMPLE PROBLEM

In this appendix an example problem using the GPPR subroutine is illustrated. In this example, a 2 independent variable function is plotted, standard size. In order for the user to implement the plotting package, data must be input into the GPPR subroutine from another program or subroutine. In this example, program EXPLOT is the means by which the plot inputs are transferred into the GPPR subroutine. In Appendix C the FORTRAN listings of program EXPLOT and the other routines forming the plotting package (GPPR, AXSCALE, and SPLNQ1) are shown. On cards 3 and 4 of EXPLOT (see page C-2), the input data points (X is the first independent variable, Y is the dependent variable) are set using a DATA card statement. The NPTS array is set to 7, 5, and 0 on card 6 indicating two curves are input. The first curve has 7 points (X and Y array elements 1-7) and the second curve has 5 points (X and Y array elements 8-12). The elements of the second independent variable array are set on card 5, page C-2, to values .5 and .821 respectively. The axis labels, main title label and second independent variable label are set on cards 7 through 11, page C-2. The call to the GPPR subroutine is shown on card 12. Most of the formal parameters have been defined above. The remaining parameters are defined with numerical values in the call statement to GPPR indicating the following:

The Y axis label has 2 elements

The X axis label has 2 elements

The main title label has 6 elements

The second independent variable label has 3 elements

The values of the Z array on the plot will have 3 significant figures to the right of the decimal

The plot will be standard size with symbols, spline curve, and grid drawn

The resulting plot generated from the CALCOMP Pen Plotter is shown in Figure B-1. The computer time required to generate the CALCOMP Pen Plotter instructions for this problem was about .6 CP (Central Processor) seconds.

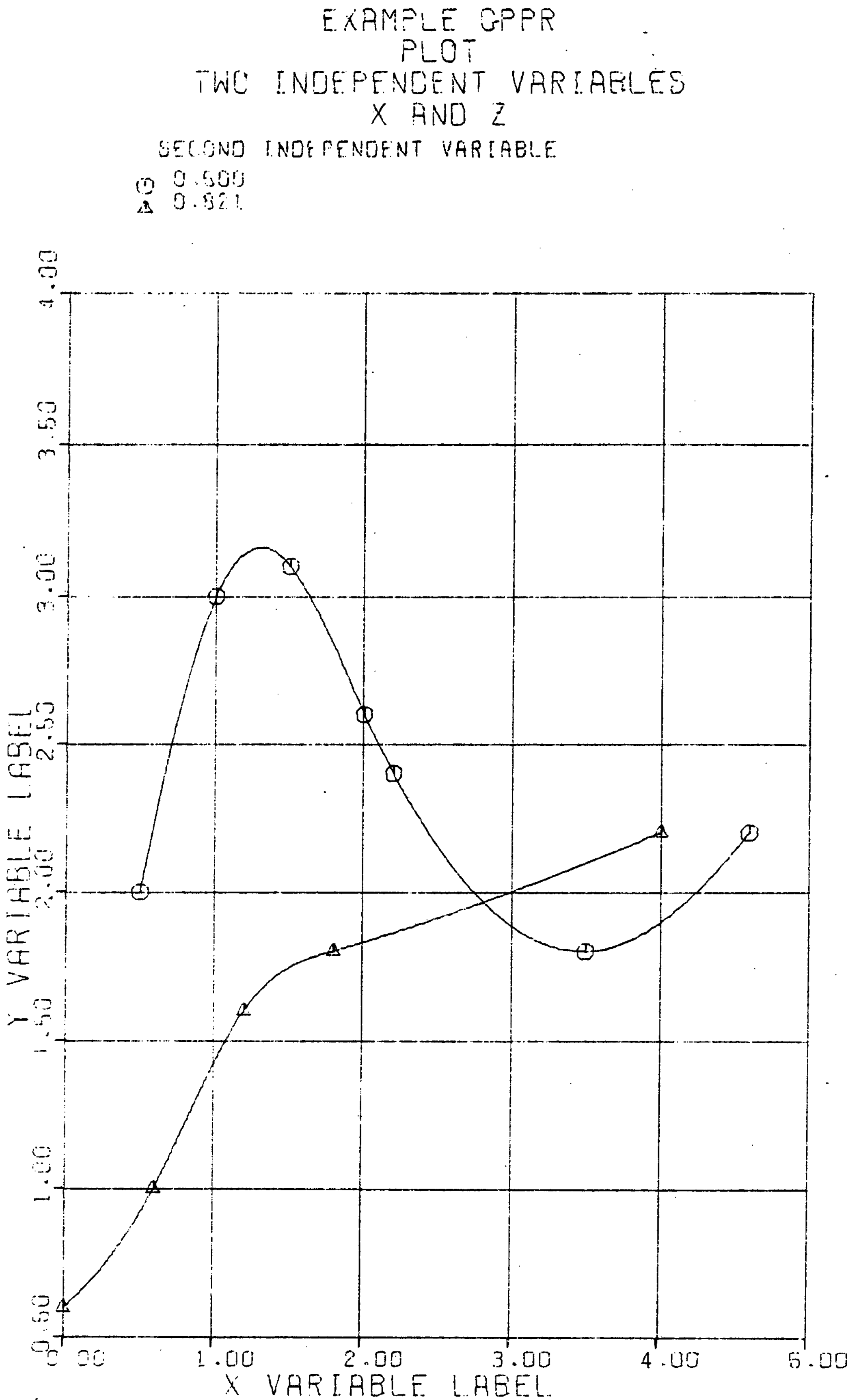

FIGURE B-1. EXAMPLE GPPR PLOT

APPENDIX C

PROGRAM LISTING

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PROGRAM EXPLOT

```
 PROGRAM EXPLOT(INPUT,OUTPUT,TAPE1)
 DIMENSION X(100),Y(100),Z(4),NPTS(5),IXT(3),IYT(3),IT(8),IZT(3)
 DATA X/1.,2.,2.2,3.5,4.6,1.5,.5,.6,1.2,1.9,4.0,0.  /
 DATA Y/3.,2.6,2.4,1.8,2.2,3.1,2.,1.,1.6,1.8,2.2,.6/
 DATA Z/.5,.821/
 DATA NPTS/7,5,0/
 DATA IXT/10HX VARIABLE,10H LABEL     /
 DATA IYT/10HY VARIABLE,10H LABEL     /
 DATA IT /10H EXAMPLE G,10HPPR    PLOT,10H   TWO IND,10HEPENDENT V,
110HARIABLES  ,10H Y AND Z        /
 DATA IZT/10H SECOND IN,10HDEPENDENT ,10HVARIABLE  /
 CALL GPPR    (NPLOT,IYT,2,IXT,2,IT,6,X,Y,NPTS,IZT,3,Z,3, 2,1,1,0)
 CALL GPPREND(NPLOT,IYT,2,IXT,2,IT,6,X,Y,NPTS,IZT,3,Z,3, 2,1,1,0)
 END
```

SUBROUTINE GPPR

```
      SUBROUTINE GPPR(NPLOT,LABY,N1,LABX,N2,LABTL,NT ,X,Y,
     1NPTS,LABVAL,NCC,VLABL,NDECV,ITIP,IGRID,FAC)
C *** GENERAL PURPOSE PLOTTING ROUTINE
C *** M CADDY AVTD
      DIMENSION X(50),Y(50),LABX(5),LABY(5),LABTL(9),NPTS(30),VLABL(6),
     1 LABVAL(6),PATA(1024),Q(101),NA(100),QS(303)
      DIMENSION IZ(10),IP(80)
      IFIT=0
      ITYP=ITIP
      IF(ITIP.GT.0) GO TO 10
      ITYP=-ITYP
      IFIT=1
   10 NY=N1*10
      NX=N2*10
      NCL=NCC*10
      NTL=NT
      IF(NPLOT.NE.0) GO TO 20
      CALL PLOTS(PATA,1024,1)
      CALL FACTOR(FAC)
      GO TO 60
   20 IF(FAC.GT.1.)  GO TO 50
      GO TO (30,40),NPLOT
   30 CALL PLOT(0.,11.0,-3)
      GO TO 60
   40 CALL PLOT(8.5,-11.0,-3)
      NPLOT=0
      GO TO 60
```

GPPR (CONTINUED)

```
 50 CALL PLOT(8.5,0.,-3)
 60 NPLOT=NPLOT+1
    Y1=8.75
    K1=1
    NTLS=1
    IF(NTL.LE.0) GO TO 160
 70 ITL1=0
    NBLK=0
    DO 130 I= NTLS,NTL
    IWORD=LABTL(I)
    DO 80 J=1,10
    IZ(J)=IWORD.AND.77000000000000000000B
 80 IWORD=SHIFT(IWORD,6)
    IF(K1.GT.10) GO TO 130
    DO 120 K=K1,10
    IF(IZ(K).NE.1L )    GO TO 90
    IF(ITL1.EQ.0) GO TO 120
    NBLK=NBLK+1
    IF(NBLK.NE.3) GO TO 100
    ITL1=ITL1-2
    GO TO 140
 90 NBLK=0
100 IF(ITL1.LT.35) GO TO 110
    IF(IZ(K).EQ.1L )  GO TO 140
110 ITL1=ITL1+1
    IP(ITL1)=IZ(K)
120 CONTINUE
```

GPPR (CONTINUED)

```
130 K1=1
    ITL1=ITL1-NBLK
140 X1=(5.-.13333*ITL1)/2.
    NTLS=1
    K1=K+1
    DO 150 I=1,ITL1
    JL=IP(I)
    CALL SYMBOL(X1,Y1,.14,JL,0.,1)
150 X1=X1+.13333
    Y1=Y1-.21
    IF(NBLK.EQ.3) GO TO 70
160 CALL PLOT(6.75,9.50,3)  $ CALL PLOT(6.75,-1.5,2)
    CALL PLOT(-1.75,-1.5,2)  $ CALL PLOT(-1.75,9.50,2)
    CALL PLOT(6.75,9.5,2)
    NL=0
    NPTOT=0
    DO 170 I=1,30
    IF(NPTS(I).EQ.0) GO TO 180
    NL=NL+1
170 NPTOT=NPTOT+NPTS(I)
180 CONTINUE
    IF(NCL.LE.0)GO TO 210
    YW=Y1
    CALL SYMBOL(.5,YW ,.10,LABVAL,0.,NCL)
    XW=.5
    YW=YW-.2
    YSAVE=YW
```

GPPR (CONTINUED)

```
      NS=NL   $IS=1   $NP=NS
  190 IF(NS.GT.5)    NP=5
      NS=NS-5
      DO 200 J=1,NP
      CALL SYMBOL(XW,YW,.10,IS,0.,-1)
      XV=XW+.2
      CALL NUMBER(XV,YW,.10,VLABL(IS),0.,NDECV)
      IS=IS+1
  200 YW=YW-.15
      NP=NS
      IF(NS.LE.0) GO TO 210
      CALL WHERE(XW,YW,FAC)
      XW=XW+.5
      YW=YSAVE
      GO TO 190
  210 CONTINUE
      CALL AXSCALE(Y,7.,NPTOT,YBEGIN,DELY,0)
      CALL AXSCALE(X,5.,NPTOT,XBEGIN,DELX,0)
      CALL AXIS(0.,0.,LABY,NY,7.,90.,YBEGIN,DELY)
      CALL AXIS(0.,0.,LABX,-NX,5.,0.,XBEGIN,DELX)
      IF(ITYP.NE.1) GO TO 230
      J=0
      DO 220 I=1,NL
      NPT=NPTS(I)
      DO 220 K=1,NPT
      J=J+1
      XP=(X(J)-XBEGIN)/DELX
```

GPPR (CONTINUED)

```
      YP=(Y(J)-YBEGIN)/DELY
      CALL SYMBOL(XP,YP,.10,I,0.,-1)
  220 CONTINUE
      GO TO 430
  230 NWAY=-1
      NC=0
      DO 420 I=1,NL
      NS=NC
      NPT=NPTS(I)
      NC=NC+NPT
      DO 240 L=1,100
  240 NA(L)=L+NS
      IF(NPT-1)300,300,250
  250 NDONE=1
      DO 280 L=2,NPT
      K1=NA(L-1)
      K2=NA(L)
      IF(IFIT.EQ.1) GO TO 260
      IF(X(K1)-X(K2))280,290,270
  260 IF(Y(K1)-Y(K2))280,290,270
  270 NA(L-1)=K2
      NA(L)=K1
      NDONE=0
  280 CONTINUE
      IF(NDONE)250,250,300
  290 NA(L)=NA(NPT)
      NPT=NPT-1
```

GPPR (CONTINUED)

```
      GO TO 250
  300 QS(1)=NPT
      DO 320 M=1,NPT
      N=M+1
      KA=NA(M)
      L=N+NPT
      XXXP=(X(KA)-XBEGIN)/DELX
      YYYP=(Y(KA)-YBEGIN)/DELY
      Q(N)=XXXP
      Q(L)=YYYP
      IF(IFIT.NE.1) GO TO 310
      QS(N)=YYYP
      QS(L)=XXXP
      GO TO 320
  310 QS(N)=XXXP
      QS(L)=YYYP
  320 CONTINUE
      QS(L+1)=0.
      QS(L+2)=1.
      IJK=NPT*2+1
      KF=10+40*(QS(N)-QS(2))
      NWAY=-NWAY
      IF(NWAY.LT.0) GO TO 330
      XIN=Q(2)
      YIN=Q(NPT+2)
      NXS=3
      GO TO 340
```

GPPR (CONTINUED)

```
330 XIN=Q(N)
    YIN=Q(L)
    NXS=N-1
340 CALL PLOT(XIN,YIN,3)
    CALL SYMBOL(XIN,YIN,.10,I,0.,-1)
    IF(NPT.LE.1) GO TO 420
    NCSP=1
    DO 410 M=1,KF
    IF(IFIT.EQ.1) GO TO 350
    XP=XIN+.025*M*NWAY
    YP=SPLNO1(1,QS,XP)
    XX=XP
    GO TO 360
350 YP=YIN+.025*M*NWAY
    XP=SPLNO1(1,QS,YP)
    XX=YP
360 IF((XX-QS(NXS))*NWAY)410,410,370
370 XSYP=Q(NXS)
    NYS=NXS+NPT
    YSYP=Q(NYS)
    CALL PLOT(XSYP,YSYP,2)
    IF(ITYP.EQ.3) GO TO 390
380 CALL SYMBOL(XSYP,YSYP,.10,I,0.,-1)
390 NCSP=NCSP+1
    NXS=NXS+NWAY
    IF(NCSP-NPT)360,400,420
400 IF(ITYP.EQ.3) 380,420
```

GPPR (END)

```
410 CALL PLOT(XP,YP,2)
420 CONTINUE
430 IF(IGRID.NE.1) GO TO 460
    XH=0.
    DO 440 IH=1,7
    YH=IH
    CALL PLOT(XH,YH,3)
    XH=5.*(IH-2*(IH/2))
440 CALL PLOT(XH,YH,2)
    YH=0.
    DO 450 IH=1,5
    CALL PLOT(XH,YH,2)
    XH=XH-1.
    CALL PLOT(XH,YH,3)
450 YH=7.*(IH-2*(IH/2))
460 RETURN
    ENTRY GPPREND
    CALL PLOT(14.,0.,999)
    RETURN
    END
```

SUBROUTINE AXSCALE

```
      SUBROUTINE AXSCALE(X,AXL,N,XSTART,XINC,ISIZE)
C ***  X-ARRY  OF DATA     AXL-AXIS LENGTH INCHES
C *** N- NO. OF POINTS IN ARRAY $ XINC-INCREMENT PER INCH
C *** XSTART FIRST NO. ON AXIS
C *** ISIZE=0 USE 10 TO THE INCH SCALING  .NOT =0 USE 20
      DIMENSION X(1),L(5)
      XMAX=XMIN=X(1) $ L(1)=1 $L(2)=2 $ L(3)=5  $L(4)=10 $ L(5)=20
      IF(ISIZE.NE.0) L(3)=4
      IF(N.LE.1) GO TO 70
      DO 60 I=2,N
      XCHECK=X(I)
      IF(XCHECK.GT.XMAX)30,40
30    XMAX=XCHECK
40    IF(XCHECK.LT.XMIN)50,60
50    XMIN=XCHECK
60    CONTINUE
70    F=(XMAX-XMIN)/AXL
      IF(F)90,80
80    F=XMAX/AXL
90    J=-10
      DO 100 I=1,20
      K=10.** J*F
      IF(K)110,100
100   J=J+1
110   DO 120 I=2,4
      IF(L(I).GT.K)130,120
120   CONTINUE
  130 XINC=L(I-1)/10.**J
      K=XMIN/XINC
```

AXSCALE (END)

```
      XSTART=K*XINC
      XH=(XMAX-XSTART)/XINC
      XL=(XMIN-XSTART)/XINC
      IF(XH.GT.(AXL+.05).OR.XL.LT.-.01) 140,150
  140 I=I+1
      GO TO 130
  150 CONTINUE
      RETURN
      END
```

FUNCTION SPLNQ1

```
      FUNCTION  SPLNQ1     (NLOC,X,XINDEP)
C     CUBIC SPLINE FIT REVISED 10/21/71 M CADDY
C     THIS VERSION HAS GAO OPTION WHERE ALL OF THE SPLINE COEFFICIENTS
C     ARE COMPUTED AND STORED IN THE ARRAY.  FOR N DATA POINTS 3*N+3
C     STORAGE LOCATIONS ARE REQUIRED FOR THE DATA AND THE COEFFICIENTS
C     NEW FEATURE IS QUICK LOOK-UP FOR LARGE ARRAYS
      DIMENSION G(100),SB(100),X(1)
      XIN=XINDEP
      NS=NLOC
      NOPTS=X(NS)
      ID=NS+NOPTS
      NSP1=NS+1
      NSP2=NS+2
      NS2=NOPTS*2+NSP1
      L=X(NS2)
      LSC=NS2+1
      IOMODE=X(LSC)
      K=1
      NL=NSP1
      NH=ID
      NTRAP=-1
      IF(NOPTS-1)130,130,10
10    IF(XIN-X(ID))30,140,20
20    NTRAP=0
      GO TO 140
30    IF(XIN-X(NSP1))40,50,60
40    NTRAP=1
```

SPLNQ1 (CONTINUED)

```
50      K=NSP2
        GO TO 150
60      IF(L)120,120,70
70      IF(XIN-X(K))80,150,100
80      NH=K
        K=K-1
90      IF(XIN-X(K))110,150,100
100     NL=K
        GO TO 120
110     NH=K
120     K=(NH-NL)/2+NL
        IF(K-NL)90,140,90
130     YOUT=X(NSP2)
        GO TO 260
140     K=NH
150     M=K
        X(NS2)=M
        N=M+NOPTS
        IF(L#IOMODE)160,160,220
160     X2=X(NSP1)
        X3=X(NSP2)
        X32=X3-X2
        Y3=X(ID+2)
        Y32=Y3-X(ID+1)
        G(1)=0.
        SR(1)=-.5
        N1=NOPTS-1
```

SPLNQ1 (CONTINUED)

```
      DO 170 I=2,N1                                    0055
      J=NSP1+I                                         0056
      K1=J+NOPTS                                       0057
      X1=X2                                            0058
      X2=X3                                            0059
      X21=X32                                          0060
      X3=X(J)                                          0061
      X32=X3-X2                                        0062
      Y2=Y3                                            0063
      Y3=X(K1)                                         0064
      Y21=Y32                                          0065
      Y32=Y3-Y2                                        0066
      W=(X3-X1)/3.-X21*SB(I-1)/6.                      0067
      SB(I)=X32/(W*6.)                                 0068
170   G(I)=(Y32/X32-Y21/X21-X21*G(I-1)/6.)/W           0069
      FM1=G(N1)/(2.+SB(N1))                            0070
      IF(L)180,180,190                                 0071
180   ID1=NOPTS                                        0072
      KQAS=NOPTS+LSC                                   0073
      X(KQAS)=FM1                                      0074
      GO TO 200                                        0075
190   ID1=ID+2-M                                       0076
200   DO 210 I=2,ID1                                   0077
      EM2=FM1                                          0080
      FM1=G(N1)-SB(N1)*FM2                             0081
```

SPLNQ1 (END)

```
      X(N1+LSC)=FM1
210   N1=N1-1
      IF(L)220,220,230
220   NSM=NS2+M-NS+1
      FM1=X(NSM-1)
      FM2=X(NSM)
230   S=X(M)-X(M-1)
      IF(NTRAP)250,240,240
240   IX=M-NTRAP
      IY=IX+NOPTS
      XS=XIN
      XIN=X(IX)
      Z1=X(M)-XIN
      Z2=XIN-X(M-1)
      YOUT=(((FM2*Z2*Z2-FM1*Z1*Z1)/2.+ X(N)-X(N-1))/S
     1-(FM2-FM1)*S/6.)*(XS-XIN)+X(IY)
      GO TO 260
250   Z2=XIN-X(M-1)
      Z1=X(M)-XIN
      YOUT=(FM1*Z1*Z1*Z1+FM2*Z2*Z2*Z2)/6./S+(X(N)/S-FM2*S/6.)*Z2
     1+(X(N-1)/S-FM1*S/6.)*Z1
260   SPLNQ1=YOUT
      RETURN
      END
```

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